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ABSTRACT

This presentation focuses on theory, research, and practice in the application of simulations to preservice and inservice teacher education. The first of three major sections presents a brief historical review, featuring the pioneering work of Bert Kersh and his associates at the Teaching Research Division of the Oregon State System of Higher Education. A short descriptive analysis is then provided of how simulation relates to representative elements of three learning theories--operant conditioning, information processing, and the cognitive approach--followed by a review of the research on the various forms of simulation employed in teacher education that was conducted from 1960 to 1985. A rationale for using simulations is offered and illustrated with a case study, which summarizes the development of a prototype classroom simulation system from initial development through field testing. Finally, some directions for future research and development are proposed. A list of references and a flow chart of the interactive video prototype complete the document. (JB)

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INSTRUCTIONAL SIMULATION: RESEARCH, THEORY, AND A CASE STUDY

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INTRODUCTION

Simulations have been used to deliver instruction in educational, military, and industrial settings for many years. Although the technique has repeatedly been demonstrated to be effective, its use has been somewhat limited in higher education because of the relatively high costs connected with the development and presentation of the materials. With the advent of computer interactive video, simulation has become more affordable for everyone. Thus, simulation holds great promise for future application in many instructional settings. This presentation will focus upon theory, research, and practice related to instructional simulations.

Let us begin with a definition of the term simulation. A good starting point is to look at the way the term is described by the major indexes of the literature of Education. Two indexes, the Current Index to Journals in Education and Resources in Education include the following explanation to clarify the meaning of the descriptor "simulation." "Duplication of the essential characteristics of a task or situation." An examination of the literature itself reveals that most writers agree with

the indexes, emphasizing the idea that simulation indeed "duplicates the essential characteristics" of reality. According to various writers, our simulated reality may be abstracted and/or simplified (Heinich, Molenda, & Russell, 1985), lifelike (Cruickshank, 1966), and/or controlled (Fink, 1973).

Simulations do more than merely present manipulated "realities," however. In addition, they call upon the learner to respond through decision-making (Rice, 1966), problem solving (Cruickshank, 1966), and/or role playing (Pollack, 1973). Further, participants in simulations must deal with the consequences of their responses (Spannaus, 1978).

While most writers appear to define simulation in slightly different terms, common elements are also evident. Based upon definitions from the literature, the following eclectic version is offered: simulations are controlled representations of real situations, calling for participants to respond, and providing some form of feedback to those responses. Instructional simulations are those simulations intended to result in predetermined learning outcomes.

It is useful, at this point, to make a distinction between simulations as defined above, and games. Games have,

as an identifying characteristic, the element of competition (Coombs, 1978; Locatis & Atkinson, 1984). Simulation games are those simulations which have the element of competition built in to the materials and processes. It will not be the intent of this paper to deal directly with simulation-games, although useful and appropriate applications to games may be derived.

This work will deal with instructional simulations as used in higher education, and will focus upon applications in the area of preservice and inservice teacher education. First, a brief historical review will be presented, featuring the pioneering work of Bert Kersh and associates at the Teaching Research Division of the Oregon State System of Higher Education. Then, a summary of research will be presented, followed by a short descriptive analysis of how simulation relates to representative elements of three learning theories. A rationale for using simulations will be offered and illustrated with a case study. Finally, some directions for future research and development will be proposed.

HISTORICAL OVERVIEW

Simulations have been successfully used for many applications in military training. Richard Braby of the Naval Training Device Center in Orlando, Florida (Twelker, d970), argues convincingly for using simulations:

> I don't think we could ever talk a pilot into having the behavior that he must perform in the aircraft. You could talk to him for 30 years and he would never be able to perform under the stress of actual flight. In other words, in the classroom you don't have the stimuli that will actually trigger the behavior...I think you have to experience it." (p. 1)

Other applications from the military have included relatively simple simulations such as "pocket blinkers which simulate the action of a ship's blinker light and enables trainees to practice Morse Code, . . . to exceedingly complex weapons systems which require teams of operators and analogue or digital computers." (Twelker, 1970, p. 2)

Likewise in industry, simulations have been used to deliver instruction. A good example is the flight simulator

used by the Boeing Company to train pilots. These simulators employ sophisticated computer and video systems to present realistic flight situations to trainees. Procedures ranging from normal flight, to emergency situations, can be simulated to provide pilot-trainees with very realistic, controlled practice environments.

In the early 1960's, Bert Kersh and associates at the Oregon State System of Higher Education's Teaching Research Division, developed and conducted research using a sort of educational "link trainer." In this case, the simulation was designed to help preservice teachers develop competencies in classroom management techniques. Later, the simulation techniques were extended to "discovery teaching" as well.

The Teaching Research program included the systematic study of three simulation packages over a period of more than eight years. Their first simulation effort was intended as a research vehicle, through which sufficient information could be obtained to develop further materials. This first simulation program, "Mr. Land's Sixth Grade," consisted of a comprehensive package including: (1) an orientation to the school and community, (2) individual records on each student, and (3) sixty problem situations presented life sized, on 16mm color sound films. Students

engaged in simulation training were placed in a room which was arranged to look exactly like an elementary classroom, complete to the teacher's desk and the American Flag. However, instead of facing a class of actual children, the "teacher" faced a large rear screen upon which a sixth grade classroom full of children, and problems, was projected. Whenever the "teacher" wanted to make a response, the film display was put on still frame, and the response was enacted in exactly the same manner as if in an actual classroom. On the basis of the "teacher's" response, a trainer/operator displayed another film showing the class' behavior either improving, or getting worse.

The Kersh group conducted many experiments on the original classroom simulator, providing important basic information for subsequent researchers. Results will be reported later in this paper. Toward the end of the 60's, additional simulations were developed and field tested. It was hoped that these "Low Cost" materials, dealing with classroom management and discovery learning techniques, would be widely disseminated. Instead of employing 16mm films, these simulations used a slide and audio tape format, with accompanying background materials. They were not developed or distributed beyond the field testing stage.

During the 60's others were also experimenting with the use of simulation in teacher education programs. Vlcek (1966), and Girod (1969), experimented with Kersh's classroom simulation materials in varied settings. Wynn (1964) examined simulations for teacher education using an "inbasket" technique. College students role playing elementary school pupils were the basis of simulations developed and studied by Dettre (1967) and Hershey, Krumboltz, & Shepard (1965). Here, college students played the part of elementary pupils to give practice in "simulated" teaching. Like Kersh, Broadbent (1967), Cruickshank (1966), and Utsey, Wallen, & Belden (1966), used 16mm films to present simulated classroom situations. Broadbent's "Brockport Simulation" presented 32 teaching problems set in a fictitious community. Ten of the problems were presented via film, the remaining ones were written materials. The stimulus situations were intended to stimulate group discussions of possible responses. These materials were also used by Cruickshank (1966). Utsey, et al., (1966) used films of children reading to give students practice in assessing reading ability.

Peer teaching, or the use of college students to simulate elementary school classes, continued to be used and studied during the 70's. Emmer (1970) focused on elementary

education situations; Lehman (1970) on the teaching of secondary school biology. Simulated situations presented through written problem descriptions were developed by Zuckerman (1979). Situations ranging from administrative tasks, to planning activities, to classroom management, were included. Participants received feedback from simulation leaders regarding the adequacy of their responses. Drawing from the work of his colleagues in the United States, Tansey (1970) developed successful simulation materials for a teacher education program at Berkshire College of Education in England.

Computer based simulations began to appear during this period. Day & Parnes (1975) developed programs which provided teacher trainees with practice in making "pupil behavioral interventions." Students interacted with a computer which simulated the behavior of five handicapped students.

Another computer based simulation was marketed through the CONDUIT system. This program, called "School Transactions," was described as follows: "This series of simulations places a prospective teacher in a realistic school setting and asks him to solve problems involving students, other teachers, parents, and administrators. Each package includes three to five different simulations. Using

these simulations, teachers can explore the effect of a variety of teaching styles and strategies." (p. 18) The materials were designed to run on Apple Computers, and are currently available.

So far, the 80's have brought interesting new developments in simulations for teacher education. For example, an entire graduate course in early childhood education was taught via an elaborate simulation (Harper, 1980). The National Center for Research in Vocational Education, Ohio State University (1982), has developed various simulations for use in training vocational education teachers. Included in the materials are role playing exercises, in-basket, case study, and gaming materials. Computers continue to be used for delivering simulations. Strang & Loper (1983) describe a microcomputer based simulation program in which the teacher trainee, hereafter referred to as "T," conducts a lesson with four students whose names are displayed on a monitor. T questions, discusses, etc., with students whose graphically designed hands pop up. The computer based simulation is controlled by an operator who is a physically isolated from T. Each teacher-student interaction is coded into the computer by the operator. A terminal display directs the operator regarding how to respond to the teacher. The pace of the

interaction is similar to reality, due to the fast program routine, and operator training. Following the lesson, the teacher is furnished with a hard copy printout of her/his "teaching profile," pertaining to relative amounts of information, positive affect, feedback, etc. Two, twenty minute sessions are included. Another microcomputer based simulation for teacher education has been developed by Schieman & Winn (1983). Here, an incident is presented via video which is stopped at a decision point. The user is then provided with alternative responses. After a response is selected and entered into a computer, a probable response is shown.

Over the past 25 years, a number of different types of simulations have been incorporated into teacher education programs. Both entire courses, and parts of courses have been presented via simulations. Techniques have ranged from in-baskets, to case studies, to role playing, to computer mediated simulations. Stimulus situations have been presented in written, filmed, live, and computer formats. Interest has remained high in spite of the rather great amount of time and expense connected with the development of the necessary materials. After review of simulation efforts during this period, one is left with the impression that the technique was continually used, but not on a large scale.

THEORY AND RESEARCH

Any instructional materials may best be developed if the design can systematically relate those materials to instructional theories. One advantage of simulation techniques resides in the extent and degree to which they can be related to major instructional and/or learning theories. For example, when Kersh first developed his classroom simulation materials in the early sixties, he based them upon a behavioristic, operant conditioning model. Later, he changed his orientation to an information processing framework as he further developed his simulations. This illustrates quite nicely, the extent to which simulation has potential connections with various theoretical explanations of learning. In this section of the paper, some of those connections will be illustrated by making them explicit. As a footnote, it should be added that space and time do not permit a fully extended explication of those connections. One or two major points of support will be identified for each position.

Briefly stated, operant conditioning theory explains learning in a stimulus, response, stimulus (reinforcement) paradigm. The relationship between the stimuli, responses,

and subsequent reinforcing stimuli, represents the crucially important relationship: reinforcements should occur rapidly and on predetermined schedules to be most effective. Here, simulations offer some special and unique training advantages. In a simulator, reinforcements can occur under conditions controlled by an operator/trainer. They can be given either in "real time," or on schedules that maximize their instructional effect. For example, in the natural setting, a reinforcement may not occur immediately, but if the simulation designer believes that it should occur right away, this can be built into the simulation sequence. Further, because simulations can exercise students through repeated trials of any problem situation, continued and repeated reinforcements may be used to shape behavior. Correct responses may thus be rapidly and efficiently developed, thanks to the controlled nature of the simulation system.

Turning to information processing explanations of learning we now find an emphasis on the processes involved in the storage, retrieval, and subsequent use of information and learned skills in new settings. The informational value of "reinforcements" or feedback now becomes very important. In the case of the Kersh materials, the feedbacks provided by the simulator were originally regarded as simply

"reinforcing stimuli." Kersh came to believe, however, that the informational value of feedback was very important, and developed the idea of "controlled feedback." Now, through prompts, cues, repeated trials, or debriefing, crucial information contained within the multiple feedback loops of the ongoing instructional situation could be made apparent to the viewer.

Cognitive approaches to the learning process emphasize the notion that learning stems from a basic reorganization of knowledge which occurs within the learner's cognitive structures. The resultant "insights" are characterized by the discovery of previously unknown relationships. Often, such insights can be facilitated when reality is distorted, when situations can be presented in compressed time, or through other techniques which make new relationships quite apparent. Simulations, with their capacity for time compression and other forms of reality manipulation, provide unique opportunities for new perceptions of reality. These can lead, upon reflection and thought, to the insightful discovery of new relationships and fundamental changes in the cognitive structure.

These illustrative examples of relationships between simulation and learning theory are indicators of the degree

to which simulation can be designed to follow various theoretical constructs. Additional cases could be made for connections between simulation and other theories as well, for example modeling/imitation, social learning theories, neurological approaches, etc. Clearly, simulation offers a vehicle for instruction which can be studied and developed within the contexts of many theoretical frameworks.

We turn now to a review of the research conducted on the various forms of simulation employed in teacher education. This review will cover a twenty five year period between 1960, and 1985. The studies will be organized into three basic categories according to their major focus: (1) feasibility studies, asking the question: "can simulations be developed and operated for reasonable costs?", (2) presentation mode studies, asking the question: "in what form(s) so simulations work best, and (3) outcome studies, asking the question: "what kinds of measurable changes in student response result from the use of simulations?" The reader will recognize that, as in most category systems, some overlapping occurs. The studies cited will be confined to those conducted on simulations for teacher education. Exceptions will be made for reports summarizing large programs of simulation research, and a few, selected simulaton studies from other fields which, in my opinion,

provide special information relevant to simulations in teacher education contexts.

Feasibility

As one reviews the studies, it quickly becomes apparent that relatively few have focused upon the feasibility question: "Is it possible to produce adequate and reliable simulations for an acceptable cost?" During the late sixties, Twelker and associates at Teaching Research in Oregon, set about to answer this question by developing and field testing two sets of simulation materials. Their objective was to produce "low cost" materials which could be used widely in teacher education programs. According to Twelker (1970)

> The original "classroom simulation" materials developed by Kersh (1963) provided students with an opportunity to react in a lifelike manner to film sequences, and to experience probable pupil consequences. Although quite effective, these pioneering efforts were limited, in terms of the expense of materials and equipment, and the time required to train even small numbers of students. These limitations led to the development of "low cost" instructional simulation materials for use in teacher education programs. (p. 11)

Two series of simulations were ultimately developed, the "Classroom Management Series," and the "Discovery Teaching Series." The classroom management series was field tested at ten sites scattered across the country. The Discovery series was not developed sufficiently to field test. Results, in the words of Twelker:

> ... revealed that the Classroom Management Series left little to be desired in way of timliness and credibility. Designwise, improvements were indicated that would be expected to have a significant, positive effect on strength, robustness, reliability and affect created by the system. Data revealed that the materials did not cause all students to reach expected proficiency, and affect was borderline in some cases. The system was found to be manageable. (p. ii)

While the system did not prove to be as effective as hoped or planned, improvements were indicated that were expected to have positive effects on the "strength, robustness, reliability, and affect" created by the system. Twelker indicated that such changes would "not be impossible to perform," and that they "should not be ignored." (p. 102) In spite of this, however, no further changes were ever made upon the materials, nor were they redeveloped or disseminated.

Thirteen years later, in 1983, Schieman and Winn developed and field tested three simulations: "Music," "Management," and "Counseling." Critical incidents were presented via an interactive videotape system. After viewing a stimulus situation presented by videotape, the student entered a response into a microcomputer, and a video sequence showing a probable response was presented. In the words of the authors, "...the results of the formative evaluation were very encouraging. All three simulations received high ratings on attitude, realism and technical quality." (p. 330) After the development of the materials had been completed, they were evaluated once more as complete packages by an external evaluator. Again, in the words of the authors "...we were pleased to conclude that all three simulations were convincing, well liked, and for the most part successful in achieving what they set out to do." (p. 331) Some limitations were noted with the relative slow speed of tape access, and a few participants indicated that they would have preferred more interaction with the materials. However, in general the findings of the field test were positive and encouraging.

Buehning and Schieman (1983) developed a classroom simulator for music teachers. As in the previous study, this simulation was presented through an interactive video

tape format. Speaking to the feasibility question, they reported:

> An evaluation conducted by an outside examiner revealed its effectiveness and indicated that the strategy can and should be an integral part of teacher training programs. This project demonstrates that available technology can be used to structure and deliver instruction in human interaction. (p. 55)

Related to the question of feasibility is the matter of the time required for students to complete simulation training. Simulations have been criticized on the grounds that they take more training time than "conventional" instruction. Coleman (1973), in summarizing the Hopkins Game Research, revealed that indeed simulation training does take more time than instruction using an "information processing" (more conventional) approach.

If simulations can be designed to reduce training time, then their feasibility is enhanced. Two studies of classroom simulation have directly investigated this question. In the first study, Twelker (1965) found that prompts made simulations more efficient, in the second study

Girod (1969), comparing audio tapes with filmed versions of simulated materials, found that the training time was reduced using the audio tape version. These data suggest that simulations can be designed for reduced instructional time, thereby increasing their feasibility relative to other instructional modes.

In at least two cases involving simulations developed for teacher education settings, Broadbent's "Brockport" simulation (1967), and the Conduit simulations (1985), materials have been disseminated through commercial publishing houses. Although no experimental test of feasibility can be reported on these materials, one assumes that their continued availability through private, for profit concerns, demonstrates cost effectiveness.

In summary, we would note that while the early attempts toward "low cost" simulation by Twelker and associates was not successful, subsequent simulations have been successfully developed and disseminated. Simulations have a potential for efficient instruction, with the most recent versions, based on interactive video formats, showing particular promise for continued low cost development.

Presentation Modes

A number of studies have sought to compare various alternative methods of presenting simulations in teacher education. Girod (1969), compared film and audio tape versions of classroom simulation materials dealing with classroom management. He found that the audio tape version required fewer learning trials to criterion, but his subjects generated a greater number of errors in responding. In another comparative study, Hershey, et al. (1965), conducted an experiment designed to look at the effects of observations in a real class, compared with simulated teaching (students teaching other students) on: course grades, final exam scores, attitudes, career plans, ability to apply psychological principles, and general course satisfaction. While he found no significant differences between his training conditions, his subjective evaluation was that the live observations had a more general benefit, while the simulations were better suited for the development of particular, specific skills.

The degree of fidelity that is optimal for effective simulations has been a question of interest to several researchers. Guetzkow (1962), in summarizing simulations developed in military settings, concludes that "In general, (these) experiments ... show that high fidelity simulations ... are not necessary for high positive transfer." (p. 40)

One of the more systematic investigations of the effects of fidelity in simulations was conducted by Bert Kersh (1965). Kersh studied the following dimensions of what was called "realism:" (1) image size: life sized vs. small (2) feedback mode: visual vs. verbal (3) response mode: enactment of responses vs. verbalization of response, and (4) orientation to simulation: large life sized projections vs. small projections. Various combinations of simulation conditions were tried, ranging along a dimension labelled "realism." The most "realistic" training conditions were those in which the trainees received life sized projected materials during their orientation sessions, and enacted responses to life sized projections of problem situations. At the other extreme, students receiving "non realistic" training had an orientation consisting of small images, then responded to situations presented by slides, on a small screen, by verbally describing what they would do.

Students undergoing simulation training under varying conditions ranging from "nonrealistic" to "realistic" were compared in terms of performance on a post test consisting of response quality to simulated situations. Kersh found no significant differences on most of the variables he examined, with the exception of the large versus small sized projections for orientation. Here, he found a slight difference in favor of the small sized "nonrealistic" mode.

His overall conclusion was that "realism" was of relatively minor importance. An interesting sidelight to this study was that further analysis uncovered the fact that all subjects were able to achieve the same level of performance regardless of entry level. It appeared that simulation could have equalizing effect in bringing students with with widely varying backgrounds to similar levels of attainment.

Using the Kersh materials, Twelker (1965) investigated the effectiveness of various types of prompts given to subjects as they proceeded through simulation training. In this study, two types of prompts were compared to training with no prompts. In one treatment, subjects were given prompts which would help to identify the problem presented in the simulated episode, in the second, subjects received prompts which would help them generate a correct response. The prompts were of a general, rather than specific nature. Training including one or both types of prompts was compared with that in which no prompts were presented. Dependent variables included training session length, post test performance, and affect. Twelker found that "problem identification" prompts had unmeasurable effects. The "response" prompts had the effect of shortening the time necessary for trainees to reach criterion.

In summary, it's not surprising that dimensions of realism have been studied. It may, however, be surprising to some, that the "realism" or fidelity of a situation has not been demonstrated to have universally any strong effects to date. Perhaps the important "reality" factor for those simulations designed to develop cognitive abilities is less related to the form of the stimulus materials than to the form of the essential decision-making dynamic which underlies the simulation process. To my knowledge, this "cognitive realism" has not been explored.

It is also not surprising that some varieties of prompting would be effective in view of the value they have demonstrated in other media-related studies. Insofar as presentation variables are concerned, research on "classroom simulation" to date would seem to indicate that the fidelity of the presentation materials may not be as important as variables related to the instructional process, such as prompting.

Cognitive Outcomes

At this point, let us turn to studies focusing upon the outcomes of simulation training. Three broad categories of outcomes will be considered. In the first, the lower levels of the Bloom (1956) Taxonomy, "knowledge and comprehension" will be emphasized. The relevant question here is whether simulations can teach students facts, principles, and

responses. The second level, which roughly corresponds with the "analysis" level of Bloom, deals with outcomes related to the discrimination of cues, and the identification of problems. Finally, the third category will be concerned with those studies which have explored the extent to which simulations have led to Bloom's "application" level, or transfer of what was learned into actual classroom settings. It is perhaps this latter category which is the most important, because it speaks to a major reason why simulations are claimed to be used: to increase one's ability to respond appropriately in actual settings. Perhaps this is why the great majority of the studies deal with the application, or transfer question, a comparatively smaller number deal with knowledge and analysis.

We begin our review with a consideration of those studies which have looked at the Bloom "knowledge and comprehension", levels. Cherryholmes (1966) after reviewing six simulation studies, rejected the hypothesis that students would learn more facts, and retain them longer using simulations as compared with "conventional classroom activities." Coleman (1973) reported contrary findings in that he found that students using simulations had an increased ability to learn facts.

When we turn to the matter of learning specific responses, the data are more clearly positive. Both Twelker (1965, 1970) and Kersh (1965) reported that students were able to learn "correct" responses during training, and exhibit them later on post tests. Since they presented problems novel to the students, these post tests could also be considered as tests of transfer as well.

Moving up the Taxonomy to "analysis," five studies will be reported. Kersh (1965), and Twelker (1965), found that their original classroom simulation materials were effective in teaching students valuable cue discrimination skills. Students were able to pick out the information necessary to identify the problems which were presented.

Similarly, using variants of the Kersh materials, Girod (1969) reported that his subjects were increasingly able to discriminate cues necessary to identify simulated problems. However, in contrary findings, Vlcek (1966) reported that simulation did not demonstrate any greater ability to develop problem identification skills when compared with no training at all. This was true regardless of whether the problems were presented via simulations, or in actual classrooms.

This brings us to the studies which have explored the applicability, or transfer of simulation training to actual settings. Kersh (1965), investigated the transferability of simulation training to actual classroom practices. Unfortunately, he had to abandon his attempt to answer this question because: (1) there was a one year interval between the time his subjects received simulation training and when they were in actual teaching situations, (2) he had no readily available instrument through which he could measure simulation's effects in a classroom, and (3) he had no control group against which his simulation trained students could be compared. Although he was unsuccessful in measuring the extent of transfer, he did circulate a questionnaire to supervising teachers which revealed that students having had simulation training were judged as being able to take over classes weeks earlier than students who had not received such training.

In a field test of Kersh's materials at Michigan State University, Vlcek (1966) reported that students undergoing simulation training, as opposed to students having no such training, were more able to solve simulated problems, but were not better problem solvers in actual classrooms.

Using a set of materials entitled the "Brockport

Simulation," Broadbent (1967) reported informal findings indicating that simulation students developed increased problem solving abilities. Likewise, Ryan (1965, 1968) found that when students solved problems presented via simulations, they exhibited an increased ability to solve problems in real settings. She concluded that practice in problem solving under realistic conditions should be given, particularly in specially created situations where students could apply their newly acquired knowledge.

Using the Kersh materials, Twelker (1965) found that students were able to learn and apply correct responses to new situations presented via simulations. Later, in reporting the results of his field testing of the "low cost" simulation materials, Twelker (1970) indicated that although he was not able to demonstrate that his system changed the classroom behavior of student teachers, he was encouraged enough to speculate that:

> It is heartening to note that the research of Forgan (1969) supports the intuitive hunches that simulation bridges the gap between the textbook and the operational situation. In fact, the ability of the system to change behavior in the classroom leads this writer to speculate that the objectives stated in

> Chapter II may be too rigid ... and should be relaxed... (p. 101, 102)

Emmer (1970) studied a peer teaching simulation experience to see if benefits would transfer to the teaching of actual pupils. He determined that transfer did indeed occur. Similarly, Zuckerman (1979) investigated transfer with his simulation program called "Hey Teach." Preservice teachers were given practice in four areas: (1) administrative tasks, (2) planning tasks, (3) implementation of instruction, and (4) classroom management. Informal reports from supervising teachers were that students who had received the "Hey Teach" program were better able to handle real classroom tasks.

Although the following study did not specifically deal with simulations used in teacher training contexts, they are included here because of their great general value. Both Coombs (1978), and Coleman (1973), summarize the long term, systematic research program in simulation/games carried on by the Center for Social Organization at Johns Hopkins University. After reviewing this extensive body of research, Coombs (1978) concluded that: (1) simulations can transmit factual information, but not better than other modes, (2) simulation does not seem to be a particularly

good way to teach cognitive skills, (3) simulation games alter the character of a class in a positive manner, and (4) simulations improve the motivation of students.

In summary, we find that when simulations are used to instruct students in factual information, the evidence is mixed regarding their effectiveness. However, indications are that simulations can develop the capacity of students to give specific responses. Similarly, although by no means overwhelming, the experimental findings suggest that simulations can be successful in teaching problem identification skills. Turning to transfer in problem solving, we find most of the studies indicating that simulation is effective in leading students to greater problem solving abilities.

Affective Outcomes

Affective responses to simulation training have also been widely studied. These fall into three categories: (1) attitudes toward the simulation instruction, (2) attitudes toward the subject of the simulation, and (3) attitudes toward self.

With regard to attitudes toward simulation instruction, in his review comparing six simulation studies with

"conventional classroom activities," Cherryholmes (1966) asserted that students participating in a simulation exercises showed more interest in instructional activities, and more readily had significantly altered attitudes.

Cherryholmes' findings were later confirmed by Cruickshank (1966), who, after studying forty students receiving 31 simulated critical incidents during the first two weeks of student teaching, reported that students reported greater satisfaction and ability to cope with teaching problems and preferred the (simulation) laboratory to starting student teaching two weeks earlier.

Similarly, Broadbent (1967) reported that students who had completed his "Brockport" simulation program rated it favorably, and "learned about themselves, their methods of reacting to attacking problems, and their relationships to students." (p. 42)

Reporting contrary findings, Twelker (1970), found some difficulties with his low cost simulation materials in their ability to hold the interest of students. He concluded that "The ability of the system to attract and hold the interest of the target audience seems marginal." (p. 99) However, he

also noted that attitudes were not unfavorable. "It could be concluded that although there is room for improvement, affect was not negative." (p. 99)

Buehning and Schieman (1983) concluded that through their classroom simulation for music teachers, "we produced a simulation that was both highly motivating for the participants and instructionally meaningful." (p. 55) In an article entitled "Changing Attitudes with the 'School game,'" Plummer (1973) reported that this simulation exercise "generated positive affect." (p. 46) However, although the students seemed to enjoy the exercise, they did not view it as one which provided learning.

In agreement with most of the research, Hershey et al., (1965) measured student affective responses to "simulated" teaching (students teaching other students), and concluded that student satisfaction with the course was enhanced through simulations.

Harper (1980) took the novel approach of teaching an entire graduate course through simulations. He noted several advantages, among which was a "high degree of student involvement." Moreover, he reported that his students rated the simulation course over lecture versions.

However, he also noted that some individuals were very critical of the simulation course.

A study by Bond (1965) investigated the effects of classroom simulation on the attitudes of education majors toward topics in educational psychology. He reported "In general, the findings of the project are not sufficiently conclusive to permit any clear cut recommendations of procedure on the use of simulation to influence attitudes of education majors toward professional course content." (p. 17) However, he also indicated that informal statements of evaluation justify continued research in the area.

In his evaluation of the Hopkins Game Program, Coleman (1973) concluded that students undergo a change of attitude toward the real life persons whose roles they assume in the simulation. This change of attitude is positive, but may be short lived. The more concrete the simulation game, the more strongly the attitude change effect seemed to be.

Two researchers found an enhancement of a student's self confidence as an effect of simulation training. Vlcek (1966), using Kersh's materials, found an increase in the self confidence of student teachers. Similarly, in a much more recent study, Schieman and Winn (1983) reported that

among other advantages of their system, students had increased confidence in their teaching ability. Finally, studies by both Broadbent (1967) and Hershey, et al., (1965) reported increases in student "self knowledge" coming from simulation training.

In summary, I report that the overwhelming evidence points to a high degree of student satisfaction with simulaton training. With few exceptions, students report favorable attitudes toward simulation. The studies are somewhat less clear on whether these favorable attitudes extend to entire courses, subject matters, and even perceptions of subject content areas such as educational psychology. Simulations do appear to have the potential of developing favorable attitudes toward any roles and positions simulated. Finally, students report increased self-knowledge and self confidence accruing from simulation training.

Conclusions From the Research

Before any conclusions can be drawn from these data, some important qualifications should be noted. First, the studies cited represent a mix of methodological approaches. Many reported findings are "informal." Furthermore,

although classroom simulation has been studied in several different contexts, few efforts have been attempted to systematically, and over a long term, investigate variables connected with the technique. For these reasons, any conclusions must be viewed as tentative, certainly not definitive. With these reservations noted, I list the following preliminary conclusions:

1. Simulations have the potential of developing the capacity of students to learn specific responses to given situations.
2. Simulations have the potential of developing the capacity of students to identify and solve problems.
3. In the design of simulation, factors related to the physical fidelity of the materials to the physical situation may be less important than the degree to which the simulation models and exercises students in realistic problem solving processes.
4. Simulations are costly to produce, but do have a potential for efficient, low cost applications, particularly when delivered via interactive video formats.
5. Students enjoy simulation exercises.
6. Students report higher levels of self understanding

and greater confidence after receiving simulation training.

After reviewing the studies of simulations used in teacher education, my overwhelming impression is that many more questions are raised than are answered. Some of the questions for future research will be given in the final section of this report.

RATIONALE

We have seen that simulations have been successfully employed in many different teacher education applications. We have also seen that the development of simulation materials can occur within a framework drawing upon several learning and instructional theoretical perspectives. Finally, the research conducted to date, while spotty and incomplete, does suggest that simulations can be used successfully in the development of higher level cognitive abilities, notably problem solving, and that simulations are viewed favorably by students.

In his now classic work entitled "Readiness for Learning," Bruner(1960) characterizes the instructional process as proceeding through three phases: acquisition,

transformation, and evaluation. Briefly, acquisition concerns precisely what the name suggests, the acquisition of information. This correlates to the lower two levels of the Bloom (1956) taxonomy. During this phase, the emphasis is upon the gathering, storage, and retrieval of information. In "transformation," learners "manipulate" knowledge to make it fit new tasks. In terms of the Bloom taxonomy, operations such as "analysis," "synthesis," and "application" occur. Finally, during the phase of "evaluation," learners judge whether the way they have manipulated information is adequate to the task. This corresponds with Bloom's "evaluation" level. Bruner indicates that "in the learning of any subject matter, there is usually a series of episodes, each episode involving the three processes." (p. 421)

In which of these phases might simulations most properly be employed? The answer is not absolute by any means, because simulations have been used to support all three. However, it is in the "transformation" and "evaluation" stages, that the greatest degree of success has been attained. At least, the literature discribing uses of simulations in teacher education contexts would suggest this. Simulations seem particularly suited to providing practice in cue discriminaton, and problem solving.

Put in the context of preservice teacher education, simulations might best be employed then, as a bridge between the facts, principles, and skills learned in educational foundations classes, and the experience of serving in an actual classroom as a student teacher, or intern. In reviewing the applications of simulations in teacher education, it is not surprising to find that this is precisely the point at which most simulations have been employed.

Simulations are useful not only for preservice, but inservice teacher education as well. Here, practicing teachers may have opportunties to try out new instructional procedures, and sharpen their discriminatory skills in simulated settings. Again, the "transformation" and "evaluation" phases as described by Bruner seem to be appropriate points in the learning process to employ simulation.

Might we conclude that simulations have no place in the initial acquisition of information? Not necessarily, although few, if any, examples of the technique being successfully employed in such settings, at least in teacher education programs, seem to exist.

Turning to the design of simulations, we find that

their optimal format seems to be related to the nature of the objectives connected with instruction. At least in teacher education, we have some evidence that high degrees of fidelity of stimulus situations may not be as crucial a factor in designing successful simulations as faithful replication of problem solving processes. Therefore, "reality" may be presented via small screens, and subjects may not be required to act out their responses as if in the actual situation. Insofar as the problem solving process is exercised, simulatons might be successfully presented by video and require verbal or written responses.

It is important to note, however, that the episodes must be believable, if not projected in life sized images. Believability requires that the problems be realistic, that possible decisions be reasonable, and that sufficient information be available for decisions to be made. Furthermore, the feedback to the learner must be such that there is little question that such feedback would indeed occur in the real situation. It is, then, the integrity of the materials which is most important. The integrity and "reality" of the decision making process which seem essential for a successful simulations.

As is true for most instructional materials, the

evaluation of simulation training systems should include both cognitive and affective elements. In the cognitive area, any factual material which is presented, and which the student is required to remember, should be measured to see if it is presented in a clear fashion. Similarly, if cue discrimination is an objective, this should be measured as well. Most simulations are designed to exercise students through problem solving strategies, so the degree to which the materials develop problem solving skills should be considered. A simulation is supposed to lead to improved performance in actual situations, so tests of transfer to actual settings should be included in most evaluations of simulation training. As in virtually any training package, attention should be paid to the objectives when designing evaluation instruments.

Similarly, affective outcomes should be a part of regular evaluation. Here, the student's attitudes toward the simulation training situation, and toward the general disciplinary content should be monitored.

The feasibility question becomes important in many, if not most, applications of simulations. The costs for developing and operating simulations should be monitored, with procedures and techniques for reducing them thoroughly explored.

A CASE STUDY

Last winter, I set about to develop some simulation materials for use in the preservice teacher education program at Seattle Pacific University. It was, and remains, my hope that a continuing, systematic program of research and development in simulation will be undertaken at Seattle Pacific, and that the present materials represent the very first beginnings of that program.

This case study will summarize the development of a prototype classroom simulation system, from initial development, through field testing. It is hoped that it will serve to illustrate, in a concrete way, the way in which simulations can be developed and used in higher educaton. This account will be given in five parts: (1) a description of the background situation, (2) questions to be answered, (3) a description of production techniques, (4) a description of the field testing, and (5) the results and conclusions.

The situation.

The materials were developed for use at Seattle Pacific University, an independent institution enrolling approximately 2500 students, located in Seattle, Washington.

Specifically, the simulations were developed for use by preservice Education students engaged in their internship program. The content of the simulations was focused on classroom management techniques for two reasons. First, it was determined that this was an area in which interns could use some additional training, and second, I had access to the classroom management principles which had been developed for Twelker's "low cost" simulation package described earlier. These classroom management principles had beed developed after a careful review of the literature, and represented a thoughtfully developed, systematic approach to classroom management. I secured permission to use the earlier content materials virtually intact. Much saving in development time was thereby attained, as this content could be used with little modification. The simulation materials were designed to exercise students in the use of the following three principles of classroom management: (1) If students are about to begin an activity where rules and standards of conduct have not been established, the teacher should establish such rules and standards; (2) When students violate the rules and standards in ways that are not disruptive of others in the class, the teacher should act in a non-disruptive manner; and (3) When students are violating the rules and standards in a disruptive way, the teacher should act with enough forcefulness to end the disruption.

The University had acquired several interactive video stations, consisting of Apple and IBM microcomputers connected to Panasonic AG 6200 videotape recorder/players. In addition, the Professional Authoring Software System (PASS) developed and marketed through the Bell & Howell Company was available for software development. The PASS materials allowed the development of branching computer managed instruction programs, incorporating video sequences.

In addition, the University had half inch, VHS format video recording and editing equipment available through its Instructional Media Center. I was experienced in the use of this equipment, having produced a number of video programs for educational use in the University. Further, I had access to a fifth grade classroom, as one of my graduate students volunteered her class for the taping.

Questions to be answered

In developing the materials, I had three different kinds of objectives. The first, and most important, was to determine the degree to which the equipment and software would allow the development, and reliable delivery of simulations through an interactive video format. These feasibility considerations could be stated as:

1. How much will it cost, in time and materials, to develop the materials.

2. Will the PASS software allow the degree of flexibility necessary for successful simulations?
3. Will the interactive video system be sufficiently reliable to allow the materials to be used in an individualized mode?
4. Will the instructions and procedures be clear and manageable for students to proceed independently?

The second type of question related to the content of the simulations. If the hardware and software systems worked, would the students gain anything of value from having gone through the simulation training? Because the materials which were developed were experimental, and because only four episodes were included, the relative amount of training in the content was rather limited. How much cognitive learning of the materials could be expected from such materials? Specifically, the relevant questions included:

1. Will the students "discover" and apply the classroom management principles as they interact with the situations?
2. Will the students be able to state the principles of classroom management two weeks after they have completed simulation training?

The third and final question concerned the question of affective student response to the simulation training. Specifically, it was: Do the students enjoy participating in the simulation exercises?

Production of the materials

Production of the prototype materials proceeded along the following stages: outline of content, flow chart, scripting, taping, video editing, CAI authoring, and initial test.

Outline of Content: It was decided that the materials would have two main sections. In the first, an introduction to classroom simulation project would be presented on video in the form of a mini-lecture. Here, the students would be informed about the general content of the package (classroom management), and would be introduced to the concept of simulation delivered via interactive video.

In the second section, the students would engage in the simulation itself by responding to four simulated classroom incidents designed to give them practice in using the classroom management principles. First, a stimulus situation would be presented via video, with the "stage being set" through audio overdubbing. After the problem had been presented, the computer would direct the student to

generate a response: "What would you do in this situation?" After the student had responded, the computer would display multiple choice options, asking the student to match the response they had made with one of the choices. After making the choice, a video sequence would be displayed showing the probable student response to that choice. Following the video sequence, the computer would deliver a text screen interpreting the feedback sequence to the student. If the response was correct, the student would move on to the next episode; if the response was incorrect, the student would be re-cycled through the original problem sequence again. Re-cycling would continue until the correct response was selected. It is possible that students might go through any episode as many as four times, as four choices of response were given.

In the final section, the principles would be summarized in the form of another mini-lecture delivered via video. In addition, the student was directed to rewind the tape, turn off the equipment, and prepare the interactive video station for the next user.

Flow Chart: A flow chart was developed, illustrating all of the branching possibilities. Please refer to the flow chart in the appendix.

Scripting: A script was developed for the introductory and final mini-lectures. The content was taken directly from the "low cost" simulation materials. No scripts were prepared for the simulation episodes. Rather, general descriptions of situations were prepared.

Taping: On the appointed day, the simulation stimulus situations, and the feedback sequences were videotaped in an actual fifth grade classroom. The children did not memorize scripted material, rather, the situations were described and they were asked to respond "naturally" as if the situation had actually occurred. If anything was said, they were directed to make responses in their own words. I was directly involved in the filming of Kersh's classroom simulation materials in the early sixties, and remembered that in that situation, the approach described above proved to give the most natural appearing sequences. The technique worked satisfactorily again, most individual sequences were taped in fewer than five takes, many requiring only one or two.

Video Editing: After the situations were taped, the mini-lectures and the situations and feedbacks were edited to a VHS format tape which would be used in the interactive video simulation program. To minimize tape travel and

thereby save time of video access, the most probable feedback sequences should have been edited to imediately follow the relevant stimulus situation. However, in the case of the prototype materials, no basis for judging which response would be most probable could be determined. Therefore, the "correct" feedback was placed immediately following the stimulus situation.

CAI Authoring: The Bell & Howell PASS system was studied and learned in sufficient depth to create the materials. This authoring system has a "prompted" and "nonprompted" versions, the former being somewhat easier and faster to learn. In the development of the materials, it was necessary to learn the procedures of the "nonprompted" version to complete the necessary programming. Text screens, and branching commands were developed and entered in a lesson called "CLASS."

Initial Test: After the CAI and video materials were developed, they were combined for a first trial. In a dissapointing turn of events, the system failed to start and stop the video sequences at the correct points. Initially, the tape had been edited to have an approximate five second "window" at the beginning and end of each sequence. It was thought that this would be sufficient to correct for error

in tape addressing. Unfortunately, this assumption proved to be incorrect. The tape was re-edited to have a fifteen second black segment at the beginning and end of each sequence. This proved to allow enough time for address error.

It became apparent that the error of tape addressing was a cumulative one. That is, each error was added to the next, so that after several stops and starts of the tape, the error became large enough to render the video unusable. This was corrected by having the video sequences automaticaly re-calibrate themselves after two episodes. This procedure, while making the video segments more accurate, had the disadvantage of creating a lengthy wait period for students while the calibration process occurred. In spite of the necessary adjustments of the system, a satisfactory prototype set of materials was finally completed.

Field Test

An Apple/Panasonic interactive video station was moved to my office so I could observe, at close hand, how the system worked as individuals interacted with the materials. A sign up sheet was prepared with time slots for twenty students. Interns were encouraged, by their supervisor, to sign up for the simulation sessions and met some optional

course requirements by doing so. More than twenty "volunteers" signed up for the simulation sessions.

When they arrived, the materials were described in general terms, then the students were directed to proceed. They were also encouraged to ask questions at any time, and to write comments on the written response forms. I made myself available for easy access to the students as they engaged in the simulation materials. Their verbal comments were recorded for later analysis. All of the students completed the simulation training.

Results and Conclusions

A number of questions were posed at the outset of the development of the prototype materials. Results will be reported in terms of these questions.

1. How much will it cost, in time and materials, to develop the materials.

   It took approximately 100 hours to develop the materials to the prototype stage. However, it should be noted that no time was required for content development as the "low cost" materials were adapted to the current project. costs of developing the materials were, of course, related to development time. In addition to this, material costs for tape, diskettes, paper, supplies, etc., was approximately $50.00. For

those interested in costs of hardware and software already on hand, it is estimated that the total cost for necessary hardware and software, including the video equipment, and assuming one interactive video station, amounts to approximately $15,000.

2. Will the PASS software allow the degree of flexibility necessary for successful simulations?

   The PASS software did permit adequate flexibility to develop the materials. Limitations were noted not in the CAI software, but in the nature of the interactive video tape system.

3. Will the interactive video system be sufficiently reliable to allow the materials to be used in an individualized mode?

   No reliability problems occured with the field test. The equipment operated flawlessly.

4. Will the instructions and procedures be clear and manageable for students to proceed independently?

   Instructions and procedures were clear enough for most of the students to follow. Some minor changes in wording were indicated. Few questions related to the instructions or procedures were noted.

5. Will the students "discover" and apply the classroom management principles as they interact with the situations?

Preliminary indications were that students were able to "discover" and apply the principles on three of the four episodes. In one case, the stimulus situation proved to be too ambiguous to elicit a response in a a number of cases. This is not a fault with the content, but rather with the way in which the stimulus situation was presented, and can be corrected in subsequent versions of the materials.

6. Will the students be able to state the principles of classroom management two weeks after they have completed simulation training?

   Testing for knowledge of the principles is scheduled for February, 1986.

7. Do the students enjoy participating in the simulation exercises?

   No formal measures were taken of student affect with the materials. However, most of the students indicated satisfaction and enjoyment in unsolicited comments as they completed the materials.

I concluded that the The prototype materials were successful. The major difficulty with the system was the time "wasted" while the video segments were located. This problem may be corrected by including provision in the materials for the students to be doing something,

responding, reading, etc., while the video sequence is located. In this way, these interruptions in the flow of the lesson can be minimized.

FUTURES

The main limitation of the interactive video system described in this paper relates to the fact that the video is tape based. Random access video disc would eliminate most, if not all of the problems of inaccurate tape access, and tape transport time. However, at the present time, production of video discs is very costly and not within the means of many potential local producers, including myself. Promising developments in video disc technology indicate that production costs may, in the near future, become low enough for local production of the type described in this paper, however. In my opinion, the advent of low cost video disc production will lead to significantly improved interactive based simulation systems.

Perhaps of greater importance than hardware refinement will be the growth of a research base from which effective and efficient simulations can be specified and designed. In reviewing the research literature on simulation in general, and teacher education applications in particular, I was

impressed by the value derived from longer term, systematic research programs, such as those conducted by Johns Hopkins in game research, and Teaching Research Divsion of the Oregon State System of Higher Education's classroom simulation research. I would agree with Tansey (1970) that "later workers (in simulation) owe a debt to Kersh, Twelker, and Cruickshank." (p. 300) This is not to deny the value of individual experiments, because they do provide relevant and useful information. However, it is when variables are systematically explored, when experiments can be replicated, and when complex interactions among treatments and subjects can be explored in repeated studies, that the much valuable and reliable information can be gained.

With this sort of programmatic effort in mind, I would propose a research agenda in which variables are systematically explored as follows. Variable categories, each with three illustrative examples are provided.

Stimulus variables

* Value of positive vs. negative examples.
* Value of various types of prompts and cues provided at various points in the simulation.
* "Realism" fidelity of the simulation to the underlying cognitive processes being simulated.

Response variables

* Individual vs. group response
* Real time vs. delayed, contemplative response
* Constructed vs. selected responses.

Sequencing variables

* Simulations location within larger instructional systems: beginning, middle, end.
* Optimal length of simulation training related to larger instructional system.
* Value of simulation for "acquisiton," "transformation," and "evaluation" phases of the learning process.

Content variables

* Ability of simulations to facilitate attain cognitive outcomes at all levels of the Bloom Taxonomy.
* Ability of simulations to effect attitude change.
* Relationship of varying simulation techniques to varying content areas.

Subject variables

* Effectiveness of simulations with varying learning styles of students.
* Effectiveness of simulations with varying ability levels of students
* Effectiveness of simulations with students posessing varying amounts of background information in a given subject.

General variables

* Effectiveness of simulations used in connection with group vs. individualized instruction.
* Effectiveness of simulation used in inductive vs. deductive instructional sequencing.
* Effectiveness of simulations used in connection with other, specific instructional approaches.

Variables such as those suggested above, should be investigated individually, and in experiments designed to examine interactions among them. A thoughtfully developed research agenda, particularly one which followed a particular learning and/or instructional theory, conducted over an adequate period of time, would provide significant benefits for future developers of simulation materials.

The simulation technique has shown itself to be an effective training mode, in some situations uniquely valuable in achieving cognitive and affective outcomes. With increasingly affordable and sophisticated hardware and software, this approach promises to add much to our ability to develop effective instructional programs. A systematic, long term research effort will help future developers to use simulations in their most effective and efficient manner. It is interesting to note that, in a recent address to the

Harvard Board of Trustees, President Derek Bok (1985) waxed eloquent about the potential benefits of simulations in promoting "active learning" in higher education. Simulation is an educational technique whose time has finally come. Let us exploit this valuable instructional technique to its greatest that we may be of greatest service to our students.

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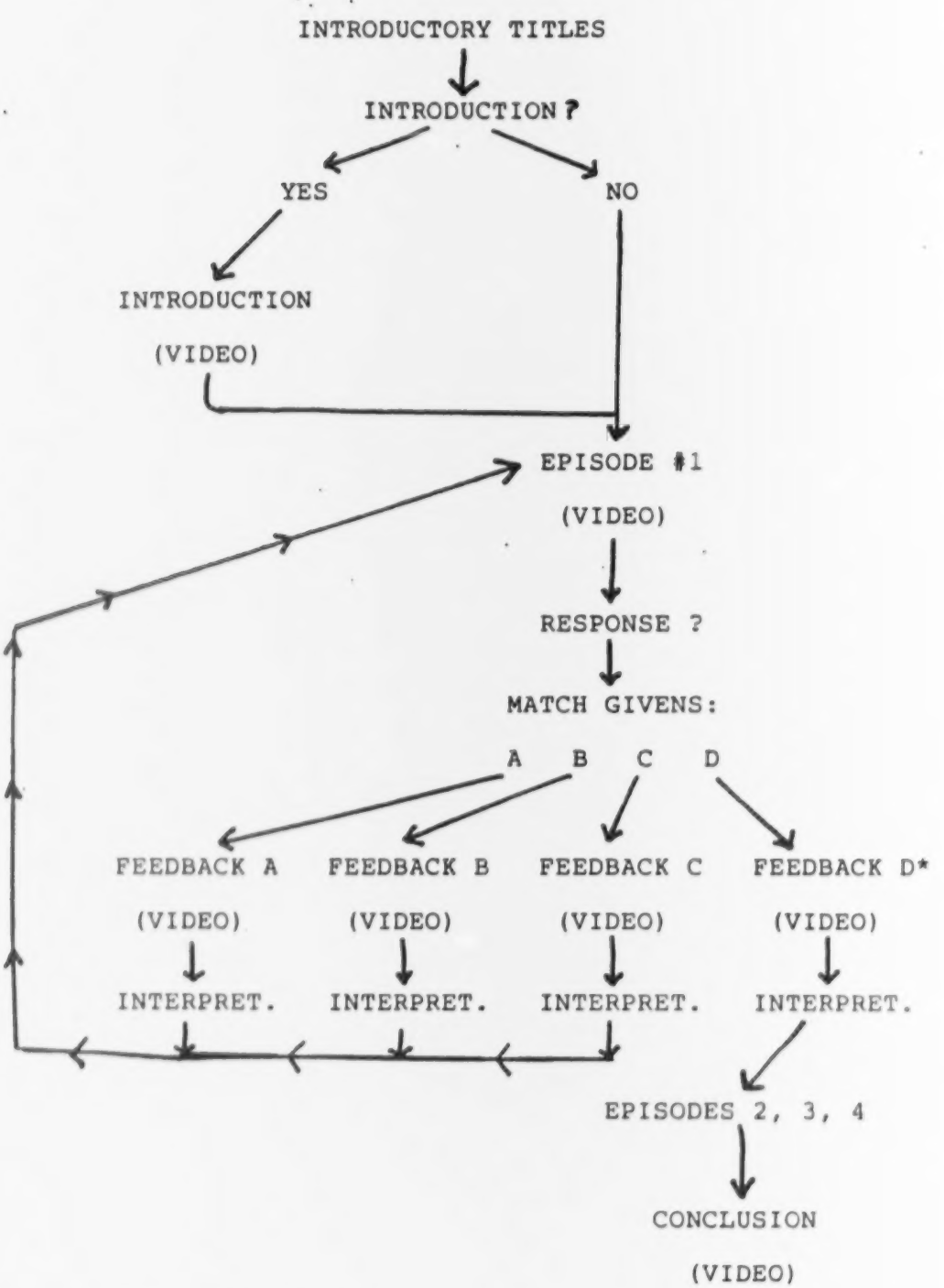
Appendix A: Flow chart of interactive video prototype.



* ASSUMES RESPONSE "D" IS CORRECT.